Sonoma Technology, Inc.

1360 Redwood Way, Suite C
Petaluma, CA 94954-1169
707/665-9900
FAX 707/665-9800
www.sonomatech.com

CALIFORNIA REGIONAL $PM_{10}/PM_{2.5}$ AIR QUALITY STUDY DATA QUALITY SUMMARY REPORTS

FINAL REPORT
STI-99924-2310-FR

BY:
Nicole P. Hyslop
Steven G. Brown
Courtney A. Gorin
Hilary R. Hafner
Sonoma Technology, Inc.
1360 Redwood Way, Suite C
Petaluma, CA 94954-1169

Prepared for:
San Joaquin Valleywide Air Pollution Study Agency
c/o Karen Magliano
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

February 20, 2003

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ACKNOWLEDGMENTS

The data quality summary reports (DQSRs) were prepared with the assistance and guidance of several Sonoma Tehcnology Inc. (STI) staff members:

- Jeffrey Prouty who provided extensive programming assistance.
- Dr. Paul Roberts, who provided invaluable technical guidance and review.
- Erin Shields who extracted data from the STI database.
- Charley Knoderer, Beverly Thompson, and Timothy Dye who prepared the DQSR for the meteorological measurements.
- STI production and editorial staff who reviewed and prepared the document.

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1. OVERVIEW

The California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS) is a multi-year program including meteorological and air quality monitoring. In order to meet the study objectives outlined by Watson et al. (1998), an extensive, high-quality database is required. Air quality data were obtained during a 14-month field program from December 1, 1999 through February 3, 2001. Sonoma Technology Inc. (STI) managed the operation of air quality and meteorological measurements at several sites (Wittig et al., 2003). The management, processing, validation, and delivery of the data collected at these sites is summarized by Hafner et al. (2003).

Data quality summary reports (DQSRs) were prepared for each parameter for which STI delivered data to the California Air Resources Board (ARB) database. The purpose of a DQSR is to provide data users with an understanding of the quality of the data collected by STI. The DQSRs are provided as appendices to this report and should be viewed as companion documents to the field report (Wittig et al., 2003) and data management report (Hafner et al., 2003). The DQSRs provide the following information:

- Operating sites and times for each parameter's measurements
- Data quality objectives
- Data recovery and completeness
- The lower quantifiable limit (LQL)
- Accuracy
- Precision

These items are discussed in subsequent sections. A summary of the DQSRs is provided in **Table 1**.

2. DATA QUALITY SUMMARY REPORT CONTENTS

The DQSRs differ among the parameters because of differences in calibration techniques, for example. For the gaseous pollutants such as ozone, periodic (e.g., quarterly) multi-point calibrations and nightly zero-span checks were performed. These checks provide ample data with which to estimate both accuracy and precision. In contrast, only the accuracy of the flow rate could be determined for the continuous particulate matter mass monitors and aethalometers. The following descriptions pertain to the gaseous instruments. Similar techniques were applied to the other instruments based on support data availability. Appendix A, for meteorological measurements at Auberry, provides additional information on equipment and the site location.

2.1 DATA OBJECTIVES

All data are subject to error, and data analysts need to understand the uncertainties in the data before embarking on their analyses. Data quality objectives (DQOs) were set for each parameter prior to the start of CRPAQS. DQOs address goals for completeness, lower quantifiable limit (LQL), accuracy, and precision.

Table 1. List of parameters and expected information.

Measurement[a]	Interval (minutes)	DQO	Completeness	LQL	Site of instrument for prec/acc[b]	Precision by calibrations	Precision by constant period	Accuracy by flow rates	Accuracy by span
Aethalometer BC(1,7)	5, 60	✓	✓	✓	ANG		✓	✓	
BAM PM_{10}	60	✓	✓	✓	ANG		✓	✓	
BAM $PM_{2.5}$	60	✓	✓	✓	ANG		✓	✓	
Meteorological		✓	✓	✓	SNF				
Nitric Acid	5, 60	✓	✓	✓	ANG	✓			✓
Nephelometer b_{sp}, RH	5, 60	✓	✓	✓	ANG	✓		✓	
Nitrate	10, 60	✓	✓	✓	ANG	✓	✓		
NO, NO_y	5, 60	✓	✓	✓	ANG	✓			✓
Ozone	5, 60	✓	✓	✓	ANG	✓			✓
OC, OCEC	60	✓	✓	✓	ANG		✓		
PAN, NO_2	5, 60	✓	✓	✓	ANG				✓
Climet OPC particle counts	5, 60	✓	✓	✓	ANG		✓		
PMS Lasair OPC	5, 60	✓	✓	✓	ANG		✓		
SMPS	5, 60	✓	✓	✓	ANG		✓		
SO_2	5, 60	✓	✓	✓	BAK	✓			✓
Sulfate	10, 60	✓	✓	✓	BAK	✓	✓		

[a] BC (1,7) = black carbon at 1- and 7-wavelengths
BAM = beta attenuation monitor
b_{sp} = light extinction coefficient for particle scattering
RH = relative humidity
NO = nitrogen oxide
NO_y = reactive nitrogen oxides
OC = organic carbon
EC = elemental carbon
PAN = peroxyacetyl nitrate
NO_2 = nitrogen dioxide
OPC - optical particle counter
SMPS = scanning mobility particle sizer
SO_2 = sulfur dioxide

[b] prec/acc = precision/accuracy
ANG = Angiola Trailer
SNF = Sierra Nevada Foothills
BAK = Bakersfield

2.2 DATA COMPLETENESS

Data capture quantifies the percentage of total records received versus the number expected during the period of operation in which the start date is the first instance of valid data and is continuous until the stop date. The number of valid data points is divided by the number of captured data points to calculate the data recovery. Validity is defined for this calculation as any data point that has a quality control flag of V0 or V1.

For each site and parameter, the following quantities were summarized:

- The total number of records delivered.
- The number of sampling periods (5-minute, 10-minute, or 60-minute) in the site-parameter operating date range (i.e., the expected number of samples).
- The percent captured.
- The number of valid data records.
- The percent recovery.
- The numbers of suspect, invalid, and missing records.

2.3 LOWER QUANTIFIABLE LIMIT

The LQL is the lowest concentration in ambient air that can be measured when actual samples are processed. Sources of variability that influence the monitored signal at low concentrations include instrument noise and atmospheric variability. As a measure of this variability, two times the standard deviation of selected 5-minute, 10-minute, and 60-minute data was used to estimate the LQL. The selected data were collected during periods when concentrations were close to the background level and were relatively stable (as measured by a rolling standard deviation). This is a conservative estimate of the LQL because it includes the concentration variability of the ambient air.

2.4 ACCURACY

Accuracy is assessing how close the measurements are to the real number and can be evaluated using deviation of measurements from a standard reference. This method quantifies the variability in the routine accuracy of the gaseous instrument by evaluating the span checks, which were performed nightly during CRPAQS.

Accuracy can be expressed in terms of the 95% confidence interval (CI). For surface ozone measurements, for example, the 95% CIs were calculated from the differences between monitor response and known concentrations provided by the automatic span checks performed every night during routine operation. The nightly span checks were performed at 80 ppb. The 95% CI approximates the accuracy of the data. The average span concentration measured was calculated by averaging the stable span measurements each night. Typically, there were six minutes of stable span measurements each night. A small number of span checks were invalidated because the instrument or the calibrator malfunctioned.

2.5 PRECISION

Precision is confidence in a measurement which can be estimated by repeated measurements or duplicate analyses (reproducibility). The consistency of the nightly span concentrations provided a measure of precision in the gaseous measurements. The precision was evaluated by comparing the measured concentration during the span check to the average measured concentration during span checks for the entire study. The coefficient of variation (CV) of the span measurements estimates the precision of the data.

3. GUIDE TO THIS REPORT

A DQSR was prepared for each instrument type as shown in Table 1 and provided in a separate appendix. **Table 2** summarizes the appendices.

Table 2. Instrument DQSRs and where to find them.

Instrument	Parameter	Appendix number
Aethalometer (1-wavelength)	Black carbon (BC)	E
Aethalometer (7-wavelength)	Black carbon (BC)	F
Beta Attenuation Monitor (BAM)	PM_{10} mass	G
BAM	$PM_{2.5}$ mass	H
Meteorological	Wind speed, wind direction, temperature, relative humidity	A
Nitric Acid	NO_y	D
Nephelometer	b_{sp}	I
Nitrate	$PM_{2.5}$ nitrate	J
NO/NO_y	NO, NO_y	D
Ozone	Ozone	B
OCEC	$PM_{2.5}$ OC, OCEC	K
NO_2/PAN	NO_2	L
NO_2/PAN	PAN	M
Climet OPC	Coarse particle size distribution in 16 fractions	N
PMS Lasair OPC	Fine particle size distribution in 8 fractions	O
SMPS	Ultrafine particle number in 50 size fractions	P
SO_2	SO_2	C
Sulfate	$PM_{2.5}$ sulfate	Q

4. REFERENCES

Hafner H.R., Hyslop N.P., and Green C.N. (2003) California Regional $PM_{10}/PM_{2.5}$ Air Quality Study management of anchor site data. Prepared for the San Joaquin Valleywide Air Pollution Study Agency and the California Air Resources Board, Sacramento, CA, by Sonoma Technology, Inc., Petaluma, CA, 999242-2087-FR (scheduled for publication May 2003).

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Wittig A.E., Blumenthal D.L., Roberts P.T., and Hyslop N.P. (2003) California Regional $PM_{10}/PM_{2.5}$ Air Quality Study anchor site measurements and operations. Final report prepared for the San Joaquin Valleywide Air Pollution Study Agency c/o California Air Resources Board, Sacramento, CA, Sonoma Technology, Inc., Petaluma, CA, STI-999231-2332-FR (scheduled for publication May 2003).

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APPENDIX A

DATA COLLECTED BY A SURFACE METEOROLOGICAL STATION AT AUBERRY, CALIFORNIA, DURING FALL 2000/WINTER 2001 FOR THE CALIFORNIA REGIONAL $PM_{10}/PM_{2.5}$ AIR QUALITY STUDY

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DATA QUALITY SUMMARY REPORT FOR OZONE DATA COLLECTED BY SONOMA TECHNOLOGY, INC., DURING THE CALIFORNIA REGIONAL PM_{10}/$PM_{2.5}$ AIR QUALITY STUDY

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